No. 3737 Skostinsky gives observations made at Pulkowa on the aureole and spectrum. The lines given are as follows :—

	λ		Intensity
1901 August 2	5010	Fairly bright line ..	10
	4960	Weak	2–3
	4861	Hβ	5
	4703	Bright, very broad..	6

ELEMENTS OF COMET 1901 I.—Mr. C. J. Merfield publishes the computed elements of the orbit of this comet in *Astronomische Nachrichten* (Bd. 156, No. 3738). The reductions are from observations made by Mr. J. Tebbutt on 1901 May 3, 11 and 19.

$$T = 1901 \text{ April } 24{\cdot}22532 \text{ G.M.T.}$$

$$\left.\begin{aligned} \omega &= 202^\circ\ 48'\ 46'' \\ \Omega &= 109\ 46\ 23 \\ i &= 131\ \ 2\ 35 \end{aligned}\right\} 1901{\cdot}0$$

$$\log q = 9{\cdot}3873832$$
$$\log e = 9{\cdot}9983750$$

THE GLASGOW MEETING OF THE BRITISH ASSOCIATION.

SECTION K.

BOTANY.

OPENING ADDRESS BY PROF. I. BAYLEY BALFOUR, LL.D. (GLASG.), F.R.S., PRESIDENT OF THE SECTION.

I SHOULD be wanting in my duty, alike to you and to our science, were I at the outset of our proceedings to pass over without notice the circumstances of environment in which we assemble to-day. In this, the first year of the century, our Section meets for the first time in Scotland, and finds itself housed in this magnificent Botanical Institute, which, through the energy and devotion of Prof. Bower, has been added this year to the equipment of Botany in this country. A few months ago the Institute was opened in the happiest auspices and with all the distinction that the presence of our veteran botanist, Sir Joseph Hooker, supported by two other ex-Presidents of the Royal Society—Lord Lister and Lord Kelvin—could give to the ceremony. I am sure we will cordially echo the words of goodwill that were spoken on that occasion. It must be to all of us a matter of congratulation that Botany has now provided for it in Glasgow this Institute both for its teaching and for the investigation of its inner secrets, and we may with confidence hope that the output of valuable additions to our knowledge of plant-life which has marked Glasgow during the tenure of office of its present distinguished Professor of Botany, and in which he himself has borne so large a share, will not only continue but will increase in a ratio not incommensurate with the facilities that are now provided.

The subject of my address is the group of Angiosperms. I will speak generally of some points in their construction from the point of view of their position as the dominant vegetation of the earth's surface at the present time, and more particularly of their relationship to water, as it is one which has much to do with their holding the position they now have. I wish, however, in the first place to refer to

The Communal Organisation of Angiosperms.

No fact of the construction of the plant-body that has been established within recent years is of greater importance than that of the continuity of protoplasm in pluricellular plants. As has been the case with so many epoch-making discoveries, we owe our first knowledge of this to the work of a British botanist. The demonstration by Gardiner of the existence of intercellular protoplasmic connections is the foundation of our modern notion of the constitution of the pluricellular plant-body and of the far-reaching conception of the communal organisation of Angiosperms and of all other Metaphyta.[1] It has settled, once and for all, phytomeric hypotheses. We now realise that in an Angiosperm the living plurinucleated protoplasm is spread over a skeletal support furnished by the cell-chambers of shoot and root. The energid of each living cell is connected with the adjacent energids by the protoplasmic threads piercing the separating cell-membrane. The protoplasm thus forms a continuous whole in the plant. According to their position in the organism the energids become devoted to the formation of special tissues for the building up of the various organs. Each one of them, however, whilst its actual destiny is ultimately determined by its relationships to the others, is, so long as its fate as a permanent element is not fixed, a potential protophyte, that is to say, it has within it all the capacities of the plant-organism to which it belongs.

Their construction out of this assemblage of protophytes—this colonial, or perhaps better communal, organisation—gives to Angiosperms their power of discarding effete and old parts of the plant-body without mutilation, of allowing these to pass out of the region of active life yet to remain without damage to the organism as part of the body, of renewing and replacing members as required. The response of the plant to the various horticultural operations of pruning, propagation by cuttings, and so forth is an outcome of this constitution. It is this which gives them the power of developing reproductive organs at any part of the plant-body, to cast them off when their work is done, and to renew them again and again. This dispersion of the reproductive capacity in the Angiosperm is one of the most striking of the properties it possesses, and is perhaps in no way better shown than in the development of stool-shoots. There the energids of the cambium, which normally produce the permanent tissue of wood and bark, and thereby add periodically to the girth of a tree, give origin when the relationships are changed by the cutting over of its bole to a callus from which stool-shoots arise as new growths, which may ultimately produce flower and reproductive organs.

Another outcome of this organisation of the Angiosperm is its power of extension and its longevity. It is potentially immortal. How far this expectation of life of a plant is realised in nature we have no evidence to show. Possibly we may presage the longest life in the case of perennial herbs. Trees and shrubs by their exposure in the air are liable to injury which must militate against long life, and yet cases of trees of great age are well known to you all.

It is this feature of the life of Angiosperms which marks them out sharply in contrast with the higher members of the animal kingdom. There we have individuality, and consequently comparatively short life. Let me emphasise this.

Of the Vegetable Kingdom and the Animal Kingdom.

The root-difference between plants and animals is one of nutrition. Plants are autotrophic, animals heterotrophic.

Whatever has been the origin of the two kingdoms, we must trace the differentiation of plants to their acquisition of chlorophyll as a medium for the absorption of the energy of the sun. The imprint of its operation is borne in the construction of all higher plants and distinguishes them from animals. The vegetative mechanism of the plant has been elaborated upon lines enabling it to obtain the materials of its food from gases and liquids which it absorbs from its environment. For the plant the primary requisite has been a sufficient surface of exposure in the medium whence it could obtain energy along with the gases and liquids of its food. To this end the fixed habit is an obvious advantage, for the question of bulk within the limits of nutrition becomes thereby not a matter of moment ; and an upward and a downward extension gives opportunity for the creation of a larger expanse of absorptive surface. Thus it has come about that the plant-organism has developed that polarity which finds expression in the profuse root-system and shoot-system with their localised growing points of the highest forms of to-day. That the communal organisation is well fitted to this mode of life requires no exposition.

The nutritive mechanism of animals, on the other hand, has become one for the ingestion of solids which it obtains by preying upon the bodies of plants and other animals. The exigencies of its feeding have compelled the adoption by the animal of the habit of locomotion, the development of an apparatus for the capture of its prey, and of an alimentary canal for its introduction to the body, for its digestion, and for the final ejection of the unused matter along with the waste of the body. This has

[1] Metaphyta and its antonym Protophyta are well-established names for groups of polyergic and monergic plants respectively. The recent appropriation of Metaphyta as a group name for Vasculares, *i.e.* plants derived from the second antithetic generation, and of Protophyta for Cellulares, *i.e.* plants derived from the first antithetic generation, is unfortunate.

involved the concentration and the specialisation of the individual.

All this is, however, to you botanists but the commonplace of your laboratories and lecture halls. But I have thought that it should be said, because this fundamental difference of organisation between the two kingdoms is apt to be forgotten in discussions of problems of evolution, more particularly those of transmission of characters and the effect of environment. This is especially so when they are approached from the zoological side. Were the point always recognised we should not have zoologists finding similarity between bud-variation in a flowering plant and the change in colour of the hair of a mammal.

Of Origin and Dominance of the Angiospermous Type.

It is now usually admitted that all plants, like all animals, have been derived from aquatic ancestors, and that the trend of evolution has been in the direction of the establishment of a vegetation adapted to a life on land. Of this evolution the Angiosperms as we see them to-day are the highest expression. Can we say anything about the origin of the angiospermous type? As the problem presents itself to me we can only mark time at present.

From the geological record we obtain no help. The earliest traces of Angiosperms in rocks of the middle Mesozoic period enable us to say little regarding them except that the fragments give evidence of an organisation as complete as that possessed by the Angiosperms of the present day. The gap between the angiospermous and other types of vegetation is a wide one, and no links are known. Until further research provides specimens in a better state of preservation and showing structure we can hope for little assistance from the geological record; and when we consider the circumstances in which the angiospermous plants as a whole grow the prospect of such finds does not appear to be very bright.

The appeal to ontogeny likewise gives us little information. Comparative study does not establish connection with, only differentiates more and more, the types of the Pteridophytes and Gymnosperms. The strong likeness of the pro-embryo after the primary segmentation of many Angiosperms to the pro-embryo of many Bryophytes has appeared a sufficient reason to some botanists for ascribing a bryophytous parentage to the Angiosperms. Indeed it has been said that "the monocotylous embryo is the direct homologue of the sporogonium of the moss, the cotyledon being homologous with the spore-producing portion of this out of which it originated." This anaphytic conception of the monocotylous embryo seems to me to have as little real foundation as the hypothesis of its origin. The pro-embryonic resemblance is interesting, but it may as well be homoplastic as genetic.

But if the information available to us does not permit of our building up a pedigree for the Angiosperms, we are on surer ground when we endeavour to fix upon characters which have enabled the group to become established as the dominant vegetation of our epoch. Before the era at which we have first knowledge of Angiosperms the earth's surface was, we know, clad with a dense vegetation composed of members of the various classes of Pteridophytes and Gymnosperms. These appear to have existed in all the growth-forms which we know now amongst the Angiosperms—Herb, Shrub, Tree, Liane. Yet they are now represented amongst living plants by only a few remanent forms. Hordes of distinct forms and whole classes have disappeared, giving place to plants of the angiospermous type. There must then be some feature or features of advantage in this type over those of the groups that previously occupied the ground, and through which it became dominant.

In considering this point we must bear in mind the well-known climatic differences—particularly in the distribution of water—that distinguish our epoch from those in which these extinct plants throve. The factors which determine the success or otherwise of an organism or group of organisms at any period must always be complex, and no exception can be claimed for plants in their struggle for mastery. But looking at the succession of plant life in the world in relation to the known diminution of water-surface and increase of land-area, and the consequent differentiation of climates, we cannot but be convinced that of these factors water is one which has had supreme influence upon the evolution of the facies of the plant-life that we see to-day. I think the statement is warranted that the Angiosperms have become dominant in great measure because in their construction the problem of the plant's relationship to water on a land-area has been solved more satisfactorily than in the case of the groups that preceded them.

The seed character—and the flower which it involves—distinguishes the Angiosperms. What, then, are the relationships to water which the formation of seed implies and through which the Angiosperm has advantage?

Two prominent risks in its relation to water attach to the process of sexual reproduction in a plant of the type of heterosporous Pteridophytes. Firstly, that of failure of moisture on the soil sufficient to promote germination of the spores; secondly, that of failure of moisture on the soil sufficient for the passage of the spermatozoid to the ovum. In addition there is the risk of failure of the fall of microspores and megaspores together upon the soil. In the Angiosperms such risks are practically abolished in the formation of flower. The stigmatic surface of the style itself provides a secretion—the more copious in a dry and sunny atmosphere—to moisten the pollen-grain and stimulate germination, and for the spontaneous movement of the spermatozoid is substituted the passive carriage of the male gamete to the ovum by the agency of the pollen-tube. Possible failure of pollination is, too, provided against by the complex mechanism of the flower in the highest forms in relation to insect-visits. The sexual act, then, might, we conceive, gradually become more and more difficult of consummation to the Pteridophyte as the area of dry land increased. To the seed-plant it was more secure by its independence of the presence of free water. The failure of performance of the function of sexual reproduction may have hastened the disappearance of Pteridophytes before the advance of the Angiosperms.

But if this flower-mechanism relieves the Angiosperm from risks in the performance of the sexual act, it imposes a new duty upon the plant, that of nursing the embryo within the sporangium. This involves a water-supply of a kind not demanded in the Pteridophytes, and we may gain some idea of the importance of this by a comparison of the trivial vascular system required to supply through the stamen the pollen-grain, with the copious system that traverses the gynæceum for the ovules. It is, however, to the ovule—the immediate nursery of the embryo—that we must look for special indications of this water-relationship of which I speak.

Perhaps no organ has given rise to more discussion than this characteristic one of flowering plants. To most of us I believe the controversy over its axial or foliar nature will be, in a measure, historical only. All recent investigations of sporangia—and to no one does Botany owe more in this respect than to Bower—tend to confirm the view that it is, and always has been, an organ *sui generis*. To that category the nucellus of the ovule is now pretty generally admitted. It is the body of a sporangium. But the nature of the tegumentary system and of the funicle which give the ovule so distinctive a character is still the subject of disagreement.[1]

I do not share a view which sees in the integuments or other parts of the ovule anything of an axial or of a foliar nature. To me the funicle is a sporangiophore—a sporangial stalk—and the tegumentary system is an outgrowth of the sporangial primordium of somewhat variable origin and development, whose first function it is to carry and store water for the embryo, and then also to serve as a food-reservoir. The whole construction is adapted to the function claimed for it. The well-developed vascular system from the placenta traverses the funicle, but the subsequent fate of the nucellus forbids its passing through this, and the needs in respect of water (and what it carries) of the embryo and of the other further developments that proceed in the embryo-sac are provided for by the production of the tegumentary outgrowths into which the vascular system may, if necessary, be continued and spread out.

That the tegumentary covering has this function we have direct proof in its penetration by haustoria, derived either from the embryo itself or from the embryo-sac, which absorb from it water and food for the developing embryo. These haustoria appear to be much more elaborate and more widespread than has been supposed, and a definite correlation has been established in many cases between them and the integuments. The thicker the integument the better developed is the haustorium.

[1] Scott's discovery of a bracteal investment to the megasporangium in Lepidocarpon is an interesting one in relation to the question of the enclosure of sporangia. It shows how in the Lepidodendreæ a covering of the sporangium could be developed, much in the same way as a carpellary envelope in Angiosperms. Whether the ovular integument or the ovarian covering in Angiosperms was the earlier development is open to discussion. I am disposed to give precedence to the ovular coat.

In some ovules where no vascular system appears in the integument, the chalazal haustorium is prominent, and it can therefore at once tap the main water-supply of the ovule. We know also of cellular ingrowths proceeding from the vicinity of the vascular system of the raphe to the interior of the embryo-sac, and these, too, may have a conducting function. All these point to a water and nutritive function in the integuments. The protective function of the tegumentary system to which attention has been chiefly directed must be primarily only slight. It only becomes prominent as the seed is formed, and then changes consonant therewith, and with its changed function, proceed within it. Nor can we now, with our increased knowledge of the ways in which the pollen-tube may reach the embryo-sac, consider the function of the integuments in forming the micropylar canal as one of so much importance to the reproductive act as was formerly supposed. We obtain, I think, a better conception of the ovule in the view that the primary function of the tegumentary system is that of a water-jacket and food store, and that it has been developed in response to the special demands for water involved in the seed-habit.[1]

To the question why there are two integuments in some cases and only one in others we can only reply that our knowledge of ovular structure and changes is yet too slight to permit of a definite opinion being expressed. We find that there is a remarkable concurrence of the unitegminous ovule with a gamopetalous corolla in the flower, for the character apparently holds for the whole of the gamopetalous Dicotyledones excepting Primulales. On the other hand, not all Polypetalæ have bitegminous ovules, whilst bitegmeny is usual in Monocotyledones. Recently the character has been used by Van Tieghem as one of prominence in his new classification of the families of Dicotyledones. But it is not so constant an one as his groups of Unitegmineæ and Bitegmineæ would lead one to suppose. The degree in which it is inconstant we cannot yet fix, because we know details of so few genera. We do know, however, that all genera in one family are not always alike in respect of it. In Ranunculaceæ, for instance, the most of the genera with radial flowers are unitegminous, whilst those with dorsiventral flowers are bitegminous. Again, in Rosaceæ, the Potentillæ are unitegminous, as is Rosa, whilst Pomeæ and Pruneæ are bitegminous; and of the Spiræeæ, Neillia is unitegminous, but the closely allied Spiræa is bitegminous.[2] In other cases the character confirms distinctions; as, for instance, in separating the unitegminous Betuleæ and Coryleæ from the bitegminous Quercineæ. The explanation of all these constructions may, I suggest, be sought for with better prospect of success in the water-relationship and food-relationship of the integuments to the embryo than in protective function and relations to pollination. It is, perhaps, not without significance from this point of view that in, for instance, the Gamopetalæ such protective function as attaches to the tegumentary system in the seed is reduced or extinguished through the development of indehiscent fruits, accompanied in many Aggregatæ and higher Heteromeræ by the sinking of the gynæceum in the torus, and in many Bicarpelletæ by its enclosure in a persistent accrescent calyx.

All the information at our disposal seems to indicate that the tegumentary system of the ovule is extremely adaptive, and that its characters are not of themselves of much phyletic import. An extended examination of its characters as an organ of the nature I have depicted in relation to embryogeny is greatly needed. It is made all the more interesting by the questions of development of endosperm opened by the discovery of "double fertilisation." There is no more promising field of investigation than this, for it must yield results infinitely more interesting than the technicalities of formal morphology which have been for too long the stimulus to ovular research. I am tempted to go further and to say that it might supply an explanation of that most puzzling of subjects, the forms and curvature of the ovule. The common assumption that these have relation to pollination and make the advent of the pollen-tube at the micropyle easier is not altogether satisfactory. For the curvature not infrequently seems to place the micropyle in a position the opposite of favourable, and there is an absence of curvature in cases where it would appear to be desirable.

I will not dwell upon the subject of the seed itself as an advantage to the Angiosperm. Its construction follows upon the successful water-relation previously secured. We all know how its manifold adaptations to dissemination bring about its fortuitous deposition upon various soils, and the embryo is placed well guarded within the seed-coat ready to take advantage of the moment when moisture is sufficient for its germination.

Whilst the seed-habit is the character which has primarily given to Angiosperms their advantage as a land-type,[1] their vegetative organs also show an advance in their relationship to water upon those of the forms they have supplanted. I have already remarked that the growth-forms of the vegetation of the present day are the same as those of old. That means that the early as well as the later groups of vegetation have solved in much the same way, so far as general form is concerned, the problem of the exposure in the atmosphere of a large assimilating area with a sufficient mechanical support and adequate water-supply. That wherever a water-carrying system is found in these growth-forms it dominates the anatomy is witness to the importance of the water-relationships I wish to emphasise.

There are two features in the water-carrying system of Angiosperms in which they are superior to the older types—namely, their general monostely and their vasa.

No one will contest that polystely is a less perfect mechanism for water-carriage in a massive plant than is monostely. The limitation imposed by it to an increment in the area of carriage contrasts unfavourably with the openness in this respect possessed by monostely. In the moister climatic conditions of the age of domination of Pteridophytes polystely may have well sufficed for the water-needs of the plants, especially of the dwarfer forms; but even then, as we know, monostely was the habit in many of the larger tree-forms, and the development of a cambium enabled them to provide for continued additions to their carrying system. Where such monostely and secondary growth occurred in these older types their adaptation in these respects to water-carriage was on lines similar to those of our dominant Dicotyledones and was effective in giving them dominance in their epoch. There is no more interesting page in the history of evolution than that—and we owe it in large measure to the labours of Scott and Seward—upon which is depicted the struggle of some polystelic forms amongst these old plants to achieve the structural facilities more easily attained through monostelic construction. The existence of polystely in a few Angiosperms only confirms the advantage which the whole group has derived from its monostely. Such polystelic forms amongst them as we know have many of them special water-adaptations, and in no case can they be said to be progressive types.

I do not need to remind you that vasa are not the exclusive possession of the angiospermous type, but they are the conspicuous feature of their carrying system, whilst the tracheid is the leading one in the older type of vegetation. All anatomical evidence indicates that vasa give greater facility to rapid transport of water than do other elements, and we may, therefore, conclude that they have been adjuvants in enabling the Angiosperm to meet effectively the demand made upon it by the drier atmospheric conditions.

I now pass on to consider from the same standpoint the classes which make up the group of Angiosperms.

Of the Classes of Angiosperms.

There has been for long a general recognition of two classes amongst the Angiosperms—Dicotyledones and Monocotyledones—separated one from the other by definite characters which I need not specially depict here. Recently, however, we have seen an attempt made by Van Tieghem to establish another class—that of Liorhizal Dicotyledones—for which is claimed a rank equal to that of the Dicotyledones and Monocotyledones. Were this valid it would be a matter of supreme importance, for whatever be the relationship between Dicotyledones and Monocotyledones there can be no doubt of their having developed as

[1] To discuss the morphological interpretations of the funicle and integument that have been advanced would carry me beyond the scope of this address. I do not know that an axial hypothesis for any part of the ovule is now maintained. The foliar interpretation of the funicle and integuments as against their sporangial nature is supported by two distinct schools of botanists. One approaches the subject from the standpoint of the anaphytose of the earlier years of last century, and appeals largely to teratology; the other from that of vascular anatomy. I do not accept the starting-point of either the one or the other.

[2] Spiræa is, however, exalbuminous, whilst Neillia is albuminous.

[1] Gymnosperms, sharing with Angiosperms the seed-habit, have in that had advantage over Pteridophytes. But their flower-mechanism is much less perfect. The reasons for their being bested as a class by Angiosperms must be complex. Gymnosperms, as a whole as we know them, are less adaptive than Angiosperms. The decadence of the cycadean line of descent may have been helped by their conservatism in the methods of water-carriage in the vegetative organs. The coniferous type has held its own in the Northern Hemisphere.

distinct groups within the whole period of which we have knowledge of them, and the existence of a third class intermediate or outside of them might lead to interesting conclusions. It is worth while, therefore, to consider the evidence on which this class is founded. It includes two of our recognised families —the Nymphæaceæ and the Gramineæ.

What is the exact position and the affinities of the Nymphæaceæ amongst Angiosperms is no new theme of discussion. That they have characters resembling those of Monocotyledones[1] has often been insisted on. Van Tieghem lays stress on what he considers the monocotylous differentiation of the root-apex and the derivation of the piliferous layer from the same meristem-initials as the cortex, whilst in the embryo he finds the two cotyledons of Dicotyledones. But the most recent observations of the embryogeny of the family go to show that the embryo is that of the monocotylous plants, the apparent dicotylous character being the result of the splitting of one cotyledon. If this be so the position of Nymphæaceæ will be amongst the Monocotyledones, a position the root-characters in Van Tieghem's view will support. But whether this be confirmed by further research or no—and a complete reinvestigation of their embryogeny and development is much wanted—what we may say at present is that it is not in features such as this one of the root-apex—which is, after all, not so simple and uniform as Van Tieghem would have it—that we are likely to find phyletic diagnostic characters of groups.

The reason for the inclusion of the Gramineæ in this new group is the assumed presence of a second cotyledon. The construction of the embryo of grasses is peculiar, as is well-known, and has for a long time been a main support of the hypothesis that the Monocotyledones are derived from the Dicotyledones; for here alone, since the dicotylous character of forms like the Dioscoreæ was shown to be untenable, was there a structure which could be interpreted as evidence of a reduced second cotyledon. The idea that the epiblast is such a structure was enunciated by Poiteau at the beginning of the last century, and along with hypotheses of the nature of the other parts of the grass-embryo has been a subject of vigorous discussion since that time. The controversy is not yet closed. Whilst we have Van Tieghem now adopting the view of the cotylar nature of the epiblast and using it as a character of fundamental taxonomic importance, we have others who as strongly uphold the interpretation of it, first formulated by Gaertner, as a winged appendage of the scutellum, which is considered to be the cotylar lamella. And, again, there are those who take the view that it is a mere outgrowth of the hypocotylar body of the embryo and without any cotylar homology. Our interpretation of the part must depend primarily upon the standpoint from which we view the embryo of Angiosperms. This I shall discuss presently. All I need say here, *àpropos* of the class of Liorhizal Dicotyledones, is that whatever the epiblast be—and for my part I am disposed to regard this simple cellular structure as merely an outgrowth with a water-function from the embryonal corm—a dispassionate consideration must lead us to hold that it is a bold step to use a character the morphological value of which can be so variously interpreted as one of primary importance for separation of a group of Angiosperms. Moreover, we must remember that the feature of the epiblast is not one of universal occurrence in the Gramineæ. If we take a well-defined tribe like the Hordeæ, as framed by Bentham and Hooker, we find that of eight of its twelve genera which have been examined for this feature five have the epiblast and three want it. And surely the fact of its presence in Triticum and absence in Secale, its presence in Elymus and absence in Hordeum, is strong evidence that the epiblast is not a character of such importance as it would have were it a reduced cotyledon as is asserted.

It appears to me, therefore, that this third class of Angiosperms has no sound foundation, no more, perhaps less, than Dictyogens and Rhizogens which appeared as parallel groups with Endogens and Exogens in Lindley's old classification. Our present knowledge allows the recognition of only two classes of the angiospermous type—the Dicotyledones and the Monocotyledones.

Of Dicotyledones and Monocotyledones.

The relationship of these two groups is involved in the origin of the angiospermous type. They may have had a common origin or they may have arisen separately; and if the former the Dicotyledones may have been a subsequent offshoot from the Monocotyledones, or the reverse may have been the case. Each of these possibilities has its supporters. Were I to maintain an opinion it would be that the two classes have arisen on separate lines of descent. The embryo-characters, as well as those of the epicotyl, can, I think, be shown to be fundamentally different and to afford no basis for an assumed phyletic connection. The differences between Hepaticæ and Musci, to take a parallel case in a lower grade, are not more conspicuous. The parallel sequence in development in the two classes is no more than one would expect, and may be regarded as homoplastic. To the question which group is the older I would answer that the Dicotyledones are by far the most adaptive and progressive if—as is not necessarily the case—this can be taken as evidence of their more recent origin. This, however, is not the matter I intend to discuss here. I wish rather to inquire if there are any features broadly characterising the groups to which, as in the case of Angiosperms as a whole, we may look for help to an explanation of the predominance at this time of the type of Dicotyledones. I think there are, but they are not to be found in the reproductive system. That is constructed on sufficiently similar lines in each class. The features I refer to are to be found in the construction of the vegetative system both in the embryo and in the adult. That of the former gives the dicotylous plant an advantage in its start on life; that of the latter, both in shoot-system and root-system, is better adapted in Dicotyledones in relation to water-supply.

I specially differentiate the embryo-condition from the adult because in our consideration of these higher plants we are apt to overlook the two distinct stages into which their life is divided, and which call for altogether different adaptations. There is, firstly, the life in the seed and in germination; and, secondly, there is the life after germination. The conditions and the manner of life are not alike in the two stages. In the first the plant is heterotrophic, in the second it is autotrophic. The functions of the portion of the plant which lives the life within the seed, and which bears the incipient epicotyl and primary root as small, at times hardly developed, parts, are to absorb food, either before germination, as in exalbuminous seeds, or during germination in albuminous seeds, to rupture the seed-coat, and to place the plumular bud and the primary root in a satisfactory position for their growth and subsequent elongation. The functions of the adult may be summarised as the development and maintenance of a large assimilating and absorbing area preparatory to reproduction.

We ought, I think, to look upon the embryo as a protocorm[1] of embryonic tissue adapted to a seed-life. Under the influence of its heterotrophic nutrition and seed-environment it may develop organs not represented in the adult plant as we see in, for instance, the embryonal intraovular and extra-ovular haustoria it often possesses. There is no reason to assume that there must be homologies between the protocorm and the adult outside an axial part with its polarity. There may be homologous organs. But neither in ontogeny nor in phylogeny is there sufficient evidence to show that the parts of the embryo are a reduction of those of the adult.[2]

The protocorm has, I believe, developed along different lines in the Dicotyledones and Monocotyledones. This has been to the advantage of the former in the provision that has been made for rapid as opposed to sluggish further development. Confining ourselves to the general case, the axial portion of the protocorm of the Dicotyledon, the hypocotyl, bears a pair of lateral outgrowths, the cotyledons, and terminates in the plumular bud and in the primary root respectively. The cotyledons are its suctorial organs, and the hypocotyl does the work of rupturing the seed and placing the plumular bud and root by a rapid

1 The anatomical characters upon which this resemblance was chiefly based are now known to be of another nature.

1 The term has already been used for the embryo of Orchideæ, where the axis is tuberous as is the structure to which the term has been given in Lycopodineæ. But tuberousness is not an essential for the designation corm.

2 I cannot pursue the subject here, nor discuss the view of the cotyledons as either ancestral leaf-forms or arrested epicotylar leaves. The analogies with existing Pteridophytes that are cited are not pertinent, for there is no evidence that Angiosperms have that ancestry, or indeed that their phylogeny was through forms with free embryos. Nor is the fact of resemblance between cotyledons and epicotylar leaves and the existence of transitions between them convincing. That the cotyledons, primarily suctorial organs, should change their function and become leaf-like under the new conditions after germination is no more peculiar than that the hypocotyl should take the form of an epicotylar internode, from which it is intrinsically different as the frequent development upon it of hypocotylar buds throughout its extent shows.

elongation[1] which commonly brings the plumular bud above ground, protected, it may be, by the cotyledons. These latter may then become the first assimilating organs unlike or like to the epicotylar leaves. In the Monocotyledones the axial portion of the protocorm has usually no suctorial outgrowths. Its apex and usually its base also are of limited growth. The plumular bud is a lateral development, and the primary root often an internal one. The suctorial function is performed by the apex of the protocorm, termed here also the cotyledon.[2] The rupture of the seed and the placing of the plumule along with the primary root—for the axis of the corm does not elongate between them—are the work of the base of the suctorial portion of the corm.

The whole arrangement in Monocotyledones is in marked contrast with that of the Dicotyledones. Instead of the free axial elongation begun in the protocorm and continued upwards and downwards in the epicotyl and primary root, there is limited axial growth of the protocorm with lateral outgrowth of the plumular bud and arrest of the primary root. These differences in the protocorm are, I think, primary, and they point to independent origins of the two groups. The advantage lies, as I have said, with the Dicotyledones, and we find that the features of development of the protocorm are continued in the adult. There is a marked contrast between the free internodal growth of the shoots of Dicotyledones with their copious root-system and the contracted stem-growth and the arrested root-system in Monocotyledones. It is interesting to note further how the monocotylous type has developed so largely upon restricted lines in the way of short rhizomatous, often tuberous, growth, whilst the dicotylous gives us the characteristic growth-form tree.

When we compare the tree-type of the Dicotyledones with that of the Monocotyledones we see at once the feature I refer to in the adult, which has given the advantage to the dicotylous type in respect of its water-supply. In Dicotyledones we have a much-branched stem ending with numerous shoots with long internodes and small apices, and bearing many small leaves which are mainly deciduous. In the monocotylous tree, of which we may take the palm as a type, there is a straight stem with short internodes, a large apex bearing few large leaves not often renewed; if there be branching it takes more or less the form of a fork. The whole of this external configuration bears relationship to the internal structure. In the Dicotyledon the open bundles of the central vascular system provide through their cambium for a continued increase of the water-carrying system and medullary rays, which, although it is to many a heresy, I hold to have profound influence upon the movement of water in trees. The buttressing of the branches is also secured, and thus is rendered possible a large assimilating area made up of a vast number of small individual surfaces, each one of which can be readily thrown off. In the Monocotyledones, on the other hand, the distribution of a large number of closed vascular bundles in a matrix without a cambium involves the provision of a broad terminal cone, gives no support, outside interstitial growth, to lateral branches, which are consequently when developed placed so as to give an equipose, and the assimilating surface has to be concentrated in a few large leaves. The possession of cambium has enabled the Dicotyledones to meet in a much better way the requirements of water-supply and strength in correlation with feeding.

The general uniformity and effectiveness of the scheme of cambial growth is a remarkable feature in the dicotylous type; but there is still a wide field of investigation in the relationships of size and distribution of vasa both to the other structural elements of the stem and to the form of the plant in relation to its environment. So far as I know the monocotylous tree-forms, there has been an attempt in two different directions to provide an increased water-carrying system in them. There is the familiar one of the secondary cortical cambium in Dracæna and other genera. In them the cambium merely repeats in its products the construction of the primary stem, and does not provide so copious an increase of carrying area as does the system in dicotylous plants. And then in such plants as Barbacenia, many Bromeliaceæ, perhaps Kingia, we have an arrangement reminiscent of the superficial root-system which is found in many polystelic arborescent Pteridophytes of the present day. There is a copious growth of adventitious roots from the central vascular cylinder, and these pass down within the cortex, and from its cells are no doubt able to draw water for the upper parts of the stem.[1] Ultimately many of these roots reach the soil. At best, however, neither of these systems has been satisfactory. All that can be said for them is that they have enabled the monocotylous trees in which they are found to hold their own in xerophilous conditions.

Of Phyla within Dicotyledones and Monocotyledones.

A brief reference only to the groups within the Dicotyledones and Monocotyledones must conclude these remarks. Whilst there is a wonderful concurrence in the opinion of botanists as to the natural groups—real phyla, whether termed cohorts, alliances, or series—into which many of the families of both Dicotyledones and Monocotyledones fall, there is irreconcilable divergence of view as to their genetic sequence or sequences. And this is not surprising when we remember that we know nothing of the starting point or points of the classes themselves; and have, moreover, no critical mark by which to diagnose a primitive from a reduced feature in many of the flower constructions to which, as characteristic of Angiosperms, importance is attached. The desire to establish a monophyletic sequence of these phyla is natural, and finds expression in pedigrees of Dicotyledones issuing from, it may be, Ranales or Piperales, of Monocotyledones from, say, Apocarpæ or Arales. But all such attempts appear to me, in the present state of our knowledge, to be in vain. We see in the phyla, as we know them, culminating series in our epoch in lines of descent; some, for instance Myrtales or Lamiales, progressive; others, like Primulales or Pandales, apparently not so. We also recognise that these series group themselves in many cases as branches of broader lines of descent; for example, in the Bicarpellatæ of Gamopetalæ, in the Helobieæ of Monocotyledones. To a greater or less degree such relationships are traceable now, and as we obtain more knowledge of the angiospermous plant-life of the world they will be widened. But this is a different thing from the carrying back the pedigree of every phylum of dicotylous and monocotylous plants to one or other of the existing ones, which may possess what are taken to be elementary characters. We have, so far as I know, no evidence to sanction the belief, or even the expectation, that there is extant any family of Dicotyledones or Monocotyledones which represents, even approximately, a primitive type in either class. The stem in each has gone, We have the twigs upon a few broken branches.

Amongst the phyla we cannot discern any one type that can be described as the dominant one. The multifarious adaptability of the angiospermous type has given us diverse forms, suited, as far as we discern, no less well to the varied environments of our epoch. Yet we are able to differentiate certain of them which take precedence alike in point of number of species and in area of distribution. If we seek for some general character that marks these advanced groups we find it in the tendency to greater investiture of the ovule, both in Dicotyledones and Monocotyledones. This is brought about in different ways; for instance, by the sinking of the gynæceum in the torus as in Compositæ, by inclusion within a persistent calyx as in Labiatæ, or within bracts as in Gramineæ. This feature, it will be observed, emphasises that which I have put in the forefront, as leading to the establishment of the angiospermous type. That it must give greater security to the embryo in relation to its water supply is obvious, although it has evidently also direct

[1] In relation to this function it is noteworthy that the hypocotyl relatively seldom in the exalbuminous seed of Dicotyledones becomes the reservoir of food-material, whereas in Monocotyledones the axis of the embryo is the usual seat of deposition.

[2] I use the term purely as an objective designation, and in the original meaning of the suctorial organ in the embryo. This terminal cotyledon in the Monocotyledones is not a leaf nor the homologue of the lateral cotyledones in the Dicotyledones. The "traceable and direct developmental history in the formation" of the two organs is clear, and they are not alike. To those who hold the contrary view a terminal leaf is no obstacle. I think, however, the question of lateral or terminal is of importance in organography. The "sympodial leaf-from-leaf evolution," described in the first epicotylar stages of Juncus, Pistia, and other plants, demands examination with the aid of modern methods. All cases of vegetative organs in which the distinctions between organs are said to break down are worthy of being looked at in the light of their relation to their nutritive environment. How nutrition affects plant-form we do not yet understand. Its effects are familiar, both in vegetative and reproductive organs. The grosser cases, in parasites, show in the extremes an abolition of most of the landmarks of morphology—"the whole scheme of formation of organs is jumbled." Heterotrophic "jumbles" do not, however, deny the ordinary morphological categories. Pseudo-terminal reproductive organs are to be expected under the cessation of growth with which their development is concurrent.

[1] I leave it to Palæophytologists to say whether this construction may sometimes account for the profusion of roots alongside of stem-structure in fossil-sections.

connection with seed-dispersal. Another general character observed in these higher groups is the greater security for economical pollination afforded by the adaptations in relation to insect-visits. At the same time the case of the Gramineæ shows us that other adaptations in this respect are not incompatible with prominence.

I will not dwell upon the influence of water upon the vegetative organs in Dicotyledones and Monocotyledones. Of all the factors of environment its effects are best known because most easily seen. The examination of plants from the standpoint of their relation to water—bearing in mind that this is physiological, and not merely physical—has already thrown a flood of light upon their forms and upon their distribution, and offers a fertile field of investigation for the future.

Water has been, then, a dominating influence at all periods in the evolution of our vegetation. The picture of its claim in this respect which I have presented to you is drawn in the broadest outline, and with the intention more of recalling points of view from which familiar facts in the life of plants may be looked at. It is just occasions like this which give the opportunity of telling to a competent audience of the impressions received by one's most recent glimpse in the kaleidoscope of plant-life. It is in this spirit I offer my imperfect sketch.

SECTION L.

EDUCATION.

OPENING ADDRESS BY THE RIGHT HON. SIR JOHN E. GORST, F.R.S., PRESIDENT OF THE SECTION.

THE invitation of the British Association to preside over the Section of Education, established this year for the first time, has been given to me as a representative of that Government Department which controls the larger, but perhaps not the most efficient, part of the education of the United Kingdom. The most suitable subject for my opening Address would therefore seem to be the proper function of National Authority, whether central or local, in the education of the people; what is the limit of its obligations; what is the part of Education in which it can lead the way; what is the region in which more powerful influences are at work, and in which it must take care not to hinder their operation; and what are the dangers to real education inseparable from a general national system. I shall avoid questions of the division of functions between Central and Local Authorities, beset with so many bitter controversies, which are political rather than educational.

In the first place, so far as the mass of the youth of a country is concerned, the Public Instructor can only play a secondary part in the most important part of the education of the young—the development of character. The character of a people is by far its most important attribute. It has a great deal more moment in the affairs of the world, and is a much more vital factor in the promotion of national power and influence, and in the spread of Empire, than either physical or mental endowments. The character of each generation depends in the main upon the character of the generation which precedes it; of other causes in operation the effect is comparatively small. A generation may be a little better or a little worse than its forefathers, but it cannot materially differ from them. Improvement and degeneracy are alike slow. The chief causes which produce formation of character are met with in the homes of the people. They are of great variety and mostly too subtle to be controlled. Religious belief, ideas, ineradicable often in maturer life, imbibed from the early instruction of parents, the principles of morality current amongst brothers and sisters and playmates, popular superstitions, national and local prejudices, have a far deeper and more permanent effect upon character than the instruction given in schools or colleges. The teacher, it is true, exercises his influence among the rest. Men and women of all sorts, from university professors to village dames, have stamped some part of their own character upon a large proportion of their disciples. But this is a power that must grow feebler as the number of scholars is increased. In the enormous schools and classes in which the public instruction of the greater part of the children of the people is given the influence on character of the individual teacher is reduced to a minimum. The old village dame might teach her half-dozen children to be kind and brave and to speak the truth, even if she failed to teach them to read and write. The head master of a school of 2000, or the teacher of a class of eighty, may be an incomparably better intellectual instructor, but it is impossible for him to exercise much individual influence over the great mass of his scholars.

There are, however, certain children for the formation of whose characters the nation is directly responsible—deserted children, destitute orphans, and children whose parents are criminals or paupers. It is the duty and interest of the nation to provide for the moral education of such children and to supply artificially the influences of individual care and love. The neglect of this obligation is as injurious to the public as to the children. Homes and schools are cheaper than prisons and workhouses. Such a practice as that of permitting dissolute pauper parents to remove their children from public control to spend the summer in vice and beggary at races and fairs, to be returned in the autumn, corrupt in body and mind, to spread disease and vice amongst other children of the State, would not be tolerated in a community intelligently alive to its own interest.

A profound, though indirect and untraceable, influence upon the moral education of a people is exercised by all national administration and legislation. Everything which tends to make the existing generation wiser, happier, or better has an indirect influence on the children. Better dwellings, unadulterated food, recreation grounds, temperance, sanitation, will all affect the character of the rising generation. Regulations for public instruction also influence character. A military spirit may be evoked by the kind of physical instruction given. Brutality may be developed by the sort of punishments enjoined or permitted. But all such causes have a comparatively slight effect upon national character, which is in the main the product for good or evil of more powerful causes which operate, not in the school, but in the home.

For the physical and mental development of children it is now admitted to be the interest and duty of a nation in its collective capacity to see that proper schools are provided in which a certain minimum of primary instruction should be free and compulsory for all, and, further, secondary instruction should be available for those fitted to profit by it. But there are differences of opinion as to the age at which primary instruction should begin and end; as to the subjects it should embrace; as to the qualifications which should entitle to further secondary instruction; and as to how far this should be free or how far paid for by the scholar or his parents.

The age at which school attendance should begin and end is in most countries determined by economic, rather than educational, considerations. Somebody must take charge of infants in order that mothers may be at leisure to work; the demand for child labour empties schools for older children. In the United Kingdom minding babies of three years old and upwards has become a national function. But the infant "school," as it is called, should be conducted as a nursery, not as a place of learning. The chief employment of the children should be play. No strain should be put on either muscle or brain. They should be treated with patient kindness, not beaten with canes. It is in the school for older children, to which admission should not be until seven years of age, that the work of serious instruction should begin, and that at first for not more than two or three hours a day. There is no worse mistake than to attempt by too early pressure to cure the evil of too early emancipation from school. Beyond the mechanical accomplishments of reading, writing, and ciphering, essential to any intellectual progress in after life, and dry facts of history and grammar, by which alone they are too often supplemented, it is for the interest of the community that other subjects should be taught. Some effort should be made to develop such faculties of mind and body as are latent in the scholars. The same system is not applicable to all; the school teaching should fit in with the life and surroundings of the child. Variety, not uniformity, should be the rule. Unfortunately, the various methods by which children's minds and bodies can be encouraged to grow and expand are still imperfectly understood by many of those who direct or impart public instruction. Examinations are still too often regarded as the best instrument for promoting mental progress; and a large proportion of the children in schools, both elementary and secondary, are not really educated at all—they are only prepared for examinations. The delicately expanding intellect is crammed with ill-understood and ill-digested facts, because it is the best way of preparing the scholar to undergo an Examination-test.

Learning to be used for gaining marks is stored in the mind by a mechanical effort of memory, and is forgotten as soon as the Class-list is published. Intellectual faculties of much greater importance than knowledge, however extensive—as useful to the child whose schooling will cease at fourteen as to the child for whom elementary instruction is but the first step in the ladder of learning—are almost wholly neglected.

The power of research—the art of acquiring information for oneself—on which the most advanced science depends, may by a proper system be cultivated in the youngest scholar of the most elementary school. Curiosity and the desire to find out the reason of things is a natural, and to the ignorant an inconvenient, propensity of almost every child; and there lies before the instructor the whole realm of Nature knowledge in which this propensity can be cultivated. If children in village schools spent less of their early youth in learning mechanically to read, write, and cipher, and more in searching hedgerows and ditch-bottoms for flowers, insects, or other natural objects, their intelligence would be developed by active research, and they would better learn to read, write, and cipher in the end. The faculty of finding out things for oneself is one of the most valuable with which a child can be endowed. There is hardly a calling or business in life in which it is not better to know how to search out information than to possess it already stored. Everything, moreover, which is discovered sticks in the memory and becomes a more secure possession for life than facts lazily imbibed from books and lectures. The faculty of turning to practical uses knowledge possessed might be more cultivated in Primary Schools. It can to a limited extent, but to a limited extent only, be tested by examination. Essays, compositions, problems in mathematics and science, call forth the power of using acquired knowledge. Mere acquisition of knowledge does not necessarily confer the power to make use of it. In actual life a very scanty store of knowledge, coupled with the capacity to apply it adroitly, is of more value than boundless information which the possessor cannot turn to practical use. Some measures should be taken to cultivate taste in Primary Schools. Children are keen admirers. They can be early taught to look for and appreciate what is beautiful in drawing and painting, in poetry and music, in Nature, and in life and character. The effect of such learning on manners has been observed from remote antiquity.

Physical exercises are a proper subject for Primary Schools, especially in the artificial life led by children in great cities: both those which develop chests and limbs, atrophied by impure air and the want of healthy games, and those which discipline the hand and the eye—the latter to perceive and appreciate more of what is seen, the former to obey more readily and exactly the impulses of the will. Advantage should be taken of the fact that the children come daily under the observation of a quasi-public officer—the school teacher—to secure them protection, to which they are already entitled by law, against hunger, nakedness, dirt, over-work, and other kinds of cruelty and neglect. Children's ailments and diseases should by periodic inspection be detected: the milder ones, such as sores and chilblains, treated on the spot, the more serious removed to the care of parents or hospitals. Diseases of the eye and all maladies that would impair the capacity of a child to earn its living should in the interest of the community receive prompt attention and the most skilful treatment available. Special schools for children who are crippled, blind, deaf, feeble-minded, or otherwise afflicted should be provided at the public cost, from motives, not of mere philanthropy, but of enlightened self-interest. So far as they improve the capacity of such children they lighten the burden on the community.

I make no apology for having dwelt thus long upon the necessity of a sound system of primary instruction: that is the only foundation upon which a national system of advanced education can be built. Without it our efforts and our money will be thrown away. But while primary instruction should be provided for, and even enforced upon, all, advanced instruction is for the few. It is the interest of the commonwealth at large that every boy and girl showing capacities above the average should be caught and given the best opportunities for developing those capacities. It is not its interest to scatter broadcast a huge system of higher instruction for anyone who chooses to take advantage of it, however unfit to receive it. Such a course is a waste of public resources. The broadcast education is necessarily of an inferior character, as the expenditure which public opinion will at present sanction is only sufficient to provide education of a really high calibre for those whose ultimate attainments will repay the nation for its outlay on their instruction. It is essential that these few should not belong to one class or caste, but should be selected from the mass of the people, and be really the intellectual *élite* of the rising generation. It must, however, be confessed that the arrangements for selecting these choice scholars to whom it is remunerative for the community to give advanced instruction are most imperfect. No "capacity-catching machine" has been invented which does not perform its function most imperfectly: it lets go some it ought to keep, and it keeps some it ought to let go. Competitive examination, besides spoiling more or less the education of all the competitors, fails to pick out those capable of the greatest development. It is the smartest, who are also sometimes the shallowest, who succeed. "Whoever thinks in an examination," an eminent Cambridge tutor used to say, "is lost." Nor is position in class obtained by early progress in learning an infallible guide. The dunce of the school sometimes becomes the profound thinker of later life. Some of the most brilliant geniuses in art and science have only developed in manhood. They would never in their boyhood have gained a county scholarship in a competitive examination.

In Primary Schools, while minor varieties are admissible, those, for instance, between town and country, the public instruction provided is mainly of one type; but any useful scheme of higher education must embrace a great variety of methods and courses of instruction. There are roughly at the outset two main divisions of higher education—the one directed to the pursuit of knowledge for its own sake, of which the practical result cannot yet be foreseen, whereby the "scholar" and the votary of pure science is evolved; the other directed to the acquisition and application of special knowledge by which the craftsman, the designer, and the teacher are produced. The former of these is called Secondary, the latter Technical, Education. Both have numerous subdivisions which trend in special directions.

The varieties of secondary education in the former of these main divisions would have to be determined generally by considerations of age. There must be different courses of study for those whose education is to terminate at sixteen, at eighteen, and at twenty-two or twenty-three. Within each of these divisions, also, there would be at least two types of instruction, mainly according as the student devoted himself chiefly to literature and language, or to mathematics and science. But a general characteristic of all Secondary Schools is that their express aim is much more individual than that of the Primary School: it is to develop the potential capacity of each individual scholar to the highest point, rather than to give, as does the Elementary School, much the same modicum to all. For these reasons it it essential to have small classes, a highly educated staff, and methods of instruction very different from those of the Primary School. In the formation of character the old Secondary Schools of Great Britain have held their own with any in the world. In the rapid development of new Secondary Schools in our cities it is most desirable that this great tradition of British Public School life should be introduced and maintained. It is not unscientific to conclude that the special gift of colonising and administering dependencies, so characteristic of the people of the United Kingdom, is the result of that system of self-government to which every boy in our higher Public Schools is early initiated. But while we boast of the excellence of our higher schools on the character-forming side of their work, we must frankly admit that there is room for improvement on their intellectual side. Classics and mathematics have engrossed too large a share of attention; science, as part of a general liberal education, has been but recently admitted, and is still imperfectly estimated. Too little time is devoted to it as a school subject: its investigations and its results are misunderstood and undervalued. Tradition in most schools, nearly always literary, alters slowly, and the revolutionary methods of science find all the prejudices of antiquity arrayed against them. Even in scientific studies, lack of time and the obligation to prepare scholars to pass examinations cause too much attention to be paid to theory, and too little to practice, though it is by the latter that the power of original research and of original application of acquired knowledge is best brought out. The acquisition of modern languages was in bygone generations almost entirely neglected. In many schools the time given to this subject is still inadequate, the method of teaching antiquated, the results unsatisfactory. But the

absolute necessity of such knowledge in literature, in science, and in commerce is already producing a most salutary reform.

The variety of types of secondary instruction demanded by the various needs and prospects of scholars requires a corresponding variety in the provision of schools. This cannot be settled by a rule-of-three method, as is done in the case of primary instruction. We cannot say that such and such an area being of such a size and of such a population requires so many secondary schools of such a capacity. Account must be taken in every place of the respective demands for respective types and grades of secondary education; and existing provision must be considered.

It must not, however, be forgotten that a national system of education has its drawbacks as well as its advantages. The most fatal danger is the tendency of public instruction to suppress or absorb all other agencies, however long established, however excellent their work, and to substitute one uniform mechanical system, destructive alike to present life and future progress. In our country, where there are public schools of the highest repute carried on for the most part under ancient endowments, private schools of individuals and associations, and Universities entirely independent of the Government, there is reasonable hope that with proper care this peril may be escaped. But its existence should never be forgotten. Universal efficiency in all establishments that profess to educate any section of the people may properly be required; but the variety, the individuality, and the independence of schools of every sort, primary and secondary, higher and lower, should be jealously guarded. Such attributes once lost can never be restored.

There still remains for our consideration the second division of Higher Education, viz., the applied or technological side. It is in this branch of Education that Great Britain is most behind the rest of the world; and the nation in its efforts to make up the lost ground fails to recognise the fact that real technical instruction (of whatever type) cannot possibly be assimilated by a student unless a proper foundation has been laid previously by a thorough grounding of elementary and secondary instruction. Our efforts at reform are abrupt and disconnected. A panic from time to time sets in as to our backwardness in some particular branch of commerce or industry. There is a sudden rush to supply the need. Classes and schools spring up like mushrooms, which profess to give instruction in the lacking branch of applied science to scholars who have no elementary knowledge of the particular science, and whose general capacities have never been sufficiently developed. Students are invited to climb the higher rungs of the ladder of learning who have never trod the lower. But science cannot be taught to those who cannot read, nor commerce to those who cannot write. A few elementary lessons in shorthand and book-keeping will not fit the British people to compete with the commercial enterprise of Germany. Such sudden and random attempts to reform our system of technical education are time and money wasted. There are grades and types in technological instruction, and progress can only be slow. It is useless to accept in the higher branches a student who does not come with a solid foundation on which to build. In such institutions as the Polytechnics at Zurich and Charlottenburg we find the students exclusively drawn from those who have already completed the highest branches of general education; in this country there is hardly a single institution where this could be said of more than a mere fraction of its students. The middle grades of technological instruction suffer from a similar defect. Boys are entered at technical institutions whose only previous instruction has been at elementary schools and evening classes; whose intellectual faculties have not been developed to the requisite point; and who have to be retaught the elements to fit them for the higher instruction. In fact there is no scientific conception of what this kind of instruction is to accomplish, and of its proper and necessary basis of general education.

Yet this is just the division of higher education in which public authority finds a field for its operations practically unoccupied. There are no ancient institutions which there is risk of supplanting. The variety of the subject itself is such that there is little danger of sinking into a uniform and mechanical system. What is required is first a scientific, well-thought-out plan and then its prompt and effective execution. A proper provision of the various grades and types of technological instruction should be organised in every place. The aim of each institution should be clear; and the intellectual equipment essential for admission to each should be laid down and enforced. The principles of true economy, from the national point of view, must not be lost sight of. Provision can only be made (since it must be of the highest type to be of the slightest use) for those really qualified to profit by it to the point of benefiting the community. Evening classes with no standard for admission and no test of efficiency may be valuable from a social point of view as providing innocent occupation and amusement, but they are doing little to raise the technical capacity of the nation. So far from "developing a popular demand for higher instruction" they may be preventing its proper growth by perpetuating the popular misconception of what real technical instruction is, and of the sacrifices we must make if our people are to compete on equal terms with other nations in the commerce of the world. The progress made under such a system would at first be slow; the number of students would be few until improvements in our systems of primary and secondary instruction afforded more abundant material on which to work; but our foundation would be on a rock, and every addition we were able to make would be permanent, and contribute to the final completion of the edifice.

It is the special function of the British Association to inculcate "a scientific view of things" in every department of life. There is nothing in which scientific conception is at the present moment more urgently required than in National Education; and there is this peculiar difficulty in the problem, that any attempt to construct a national system inevitably arouses burning controversies, economical, religious, and political. It is only a society like this, with an established philosophical character, that can afford to reduce popular cries about education (which ignore what education really is, and perpetuate the absurdity that it consists in attending classes, passing examinations, and obtaining certificates) to their true proportions. If this Association could succeed in establishing in the minds of the people a scientific conception of a National Education System, such as has already been evolved by most of the nations of Europe, the States of America, and our own Colonies, it would have rendered a service of inestimable value to the British nation.

GEOLOGY AT THE BRITISH ASSOCIATION.

AN arduous week's work was carried out in the Section of Geology at Glasgow. There was a full list of papers—in fact, too full for adequate discussion of all—ranging widely over the whole group of sciences combined under the name of geology. While stratigraphical papers were, as usual, in the ascendancy, petrology and palæontology were both strongly represented, mineralogy (with crystallography), of late years somewhat neglected in this Section, counted several contributions, and matters of physical and economic geology received attention in others. Many of the papers were admirably adapted for initiating discussion, and in some instances fulfilled this purpose, though, as generally happens with a heavy list, the discussions were somewhat unequally distributed. It might, perhaps, be said of many of the papers that they were instructive summaries of what was already known rather than new additions to our knowledge. The general arrangement was that the papers dealing with Scottish geology were taken as far as possible on Thursday and Friday, Saturday was given up to excursions, palæontological subjects occupied most of the Monday sitting, mineralogical papers were given precedence on Tuesday, and the concluding session on Wednesday served for the postponed or unclassified contributions. In the following outline of the proceedings of the Section we shall not have space to mention all the papers which were read, and must content ourselves with brief mention of those which seemed to us to be of chief interest.

After the president's address on Thursday, already printed in our columns, a paper on recent discoveries in Arran geology, by Mr. W. Gunn, of H.M. Geological Survey, read by Mr. Peach, gave a general summary of recent important advances in our knowledge of the island. Among its older rocks a series of dark schists and chert, unfossiliferous but probably of Arenig age, have been discovered; the Old Red Sandstone has been found to comprise two subdivisions, of which the upper is unconformable on the lower; the Carboniferous, including beds probably of Coal Measure age, are overlapped unconformably by the New Red rocks, the latter consisting of sandstones, conglomerates and marls which seem to be of Triassic age.